Chapter 1

Quality Assurance of Air Monitoring

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1.0 Introduction

This chapter is designed to provide an overview of the minimum requirements for a quality assurance program for air monitoring networks. Requiring monitoring networks to meet these criteria allows the data from other monitoring networks to be compared in a meaningful way.

A quality assurance program encompasses all phases of ambient air sampling and data analysis. These phases include such things as site selection, monitoring equipment selection, audit/calibration equipment and procedures, sampling procedures, data validation, Chain-of-Custody, data reporting, precision/accuracy reporting, and meteorological issues. The Indiana Department of Environmental Management's (IDEM), Office of Air Quality (OAQ), Quality Assurance Manual (QAM), which serves as the State's Quality Assurance Project Plan (QAPP), endeavors to address ambient monitoring and quality assurance issue requirements in a user-friendly format. Additional information, by parameter, is contained in each specific chapter. Prior to the implementation of any ambient monitoring network becoming operational, a working knowledge of all the applicable chapters in this manual is necessary by those personnel designated as Quality Assurance (QA) and Quality Control (QC).

2.0 Federal Requirements

There are three basic sections of the Code of Federal Regulations (CFR) Title 40, Protection of the Environment, which deal with Ambient Air Monitoring. 40 CFR Part 50 lists the National Primary and Secondary Ambient Air Quality Standards. 40 CFR Part 53 lists alternate equivalent air monitoring methods and procedures for obtaining equivalency. Finally, 40 CFR Part 58 gives detailed descriptions of monitoring methodology, network design and siting, PSD requirements, and quality assurance criteria. Additional Federal requirements are also given in USEPA Technical Assistance Documents and USEPA QA Guidance Documents. Designated quality assurance personnel should maintain a working knowledge of all applicable requirements. All monitoring and QA program requirements should be kept current and accessible.

3.0 Indiana Requirements

All intermittent and continuous air quality monitoring conducted in Indiana shall meet the requirements listed on the following pages. These requirements are the minimum needed for a competent monitoring program in Indiana.

3.1 Data Assessment Requirements

Air quality data must have precision and accuracy (P&A) assessments performed. These assessments are made on each monitor at each monitoring site. There are requirements for the methods used, which also depends if it is automated or manual. This includes how frequent measurements are made, limits on how much deviation is allowed for measurements, and the determination of system bias. Table 1 lists these requirements. Also acceptable completeness for all methods is $\geq$75% of total number possible, except $\geq$80% for PSD sites, and 100% for all lead analysis. This method of reporting is covered in detail in Chapter 13 of this manual. The data is reported to Air Quality System (AQS), which is operated and maintained by the USEPA's Office of Enforcement and Compliance Assurance (OEAC).

Table 1
Minimum Data Assessment Requirements

Parameter Method	Assessment Method	Coverage	Frequency	Measured Quality Objectives
Automated Methods				
One-Point QC O_3, SO_2, NO_2, CO	Response check at .01-0.1 ppm O_3, SO_2, NO_2; Response check at 1-10 ppm CO	Each analyzer each site	Once per 2 weeks (LEADS sites weekly)	Precision 7% O_3, Bias ±7% O_3, Precision 10% SO_2 and CO, 15% NO_2 Bias ±10% SO_2, CO and NO_2
Annual Performance Evaluation SO_2	Response check at .0500-.0999 ppm, .1500-.2599, .2600-.7999	Each analyzer each site	Each analyzer each qtr.	Percent difference of audit levels 3-10 ≤15%; Audit levels 1&2 ±1.5 ppb difference or ±15%
NO_2	Response check at .0500-.0999 ppm, .1000-.2999, .3000-.4999	Same as above	Same as above	Same as above
O_3	Response check at .070-.089 ppm, .140-.169, .190-.259	Same as above	Same as above	Same as above
CO	Response check at 3.000-7.999 ppm, 16.000-30.999, 40.000-50.000	Same as above	Same as above	Percent difference of audit levels 3-10 ≤15%; Audit levels 1&2 ±0.3 ppm difference or ±15%
Flow Rate Verification PM_{10}, $PM_{2.5}$ and $PM_{10-2.5}$	Check of sampler flow rate	Each sampler each site	Once every month	≤4% of standard and 5% of design value
Semi-Annual Flow Rate Audit PM_{10}, $PM_{2.5}$ and $PM_{10-2.5}$	Check of sampler flow rate	Each sampler each site	Each sampler each quarter	≤4% of standard and 5% of design value
Collocated Sampling $PM_{2.5}$	Collocated samplers	15% within PQAO	Once every 12 days	Precision 10%
Analytical Pb	Collocated Filter analysis	Same as above	Over all 4 quarters	See Chapter 13 of this Manual

(Table continued on next page)

Table 1
Minimum Data Assessment Requirements
(continued)

Parameter Method	Assessment Method	Coverage	Frequency	Measured Quality Objectives
Manual Methods				
Collocated Sampling Pb-TSP, Pb-PM_{10}, PM_{10}, $PM_{2.5}$, $PM_{10-2.5}$	Collocated samplers	15% within PQAO	Every 12 days (PSD every 6 days)	Precision 10% PM_{10}, TSP, $PM_{2.5}$; 15% $PM_{10-2.5}$
Flow Rate Verification PM_{10} (low Vol), $PM_{10-2.5}$, $PM_{2.5}$, Pb-PM_{10}, PM_{10} (High Vol), Pb-TSP	Check of sampler flow rate	Each sampler each site	Once every month	$\leq$4% of standard and 5% of design value except for PM_{10} (High Vol), Pb-TSP, which is ±7% of standard and PM_{10} (High Vol) $\pm$10% of design flow.
Semi-Annual Flow Rate Audit PM_{10} (low Vol), $PM_{10-2.5}$, $PM_{2.5}$, Pb-PM_{10}, PM_{10} (High Vol), Pb-TSP	Check of sampler flow rate	Each sampler each site	Each sampler each quarter	$\leq$4% of standard and 5% of design value except for PM_{10} (High Vol), Pb-TSP, which is ±7% of standard and PM_{10} (High Vol) $\pm$10% of design flow.
Analytical Pb	Check analytical system with Pb standard	Once per analysis	Each quarter	±15%

The following is a brief explanation of the AQS:

AQS is a system administered by the US Environmental Protection Agency (EPA) to access the status of the Nation's air quality. It is a Web based application used by State, Local, and Tribal agencies and their delegates to submit their data directly to EPA. AQS contains not only air pollution data, but also houses: meteorological data, descriptive information about each monitoring station, and data quality and assurance information. The Office of Air Quality Planning and Standards (OAQPS) and other AQS users rely upon the system data to access air quality, assist in attainment/non-attainment designations, evaluate state implementation plans for non-attainment areas, perform modeling for permit review analysis, and other air quality management functions.

3.2 Continuous Analyzer Calibration Requirements

Each individual analyzer should be calibrated in accordance with USEPA protocols and with the manufacturer's suggested guidelines. Analyzer calibrations must be in accordance with requirements outlined in this manual.

Calibration of an analyzer establishes the quantitative relationship between the actual pollutant concentration input (in ppm, $\mu g/m^3$, etc.) and the analyzer's response (chart recorder reading, output volts, digital output, etc.). This relationship is used to convert subsequent analyzer response values to corresponding pollutant concentrations.

Calibrations and audits must be carried out at the field monitoring site by allowing the analyzer to sample test atmospheres containing known pollutant concentrations. The analyzer to be calibrated should be in operation for at least several hours (preferably overnight) prior to the calibration so that it is fully warmed up and its operation has stabilized. During the calibration, the analyzer should be operated in its normal sampling mode, and it should sample the test atmosphere through all filters, scrubbers, conditioners, and any other components used during normal ambient sampling and through as much of the ambient air inlet system as practicable.

A multi-point calibration consists of a zero concentration (pollutant free air) and four (4) upscale points. The highest point needs to be a concentration above the NAAQS (for SLAMS criteria pollutants) and higher than any routine values one might expect at the site. This multi-point calibration should be performed at the time of initial installation. A multi-point calibration of an analyzer must be performed when:

A. A six (6) month period has lapsed since the most recent multi-point calibration.

B. If all calibration points are not within ±2% of the full range of the analyzer (e.g., if the range is 0.5 ppm, then all measured values must be within .010 ppm of the standard).

C. After an interruption of more than a few days.

D. Any repairs which <u>may</u> affect calibration, such as replacement of electronic boards, optics, solenoids, etc.

E. Physical relocation of the analyzer.

F. Any other indication of possible significant inaccuracy of the analyzer.

3.3 Continuous Analyzer Audit Requirements

With the exception of LEADS sites <u>all</u> continuous gas analyzers are audited every two weeks. Each audit consists of a one-point quality control (precision) check, a zero check, and a span check (data validation check). These biweekly precision/zero/span checks are done in conjunction with a 3 or 4 point accuracy audit (see performance check for each respective monitor) at least once per quarter. Sites which utilize LEADS run an automated daily zero/span and a weekly precision check. Accuracy audits are once per quarter performed by the Quality Assurance Section.

3.3.1 Definitions of Zero/Span/One-Point Quality Control Check

Daily zero and span checks are ran. These checks are used to catch analyzer drift and to help determine data validation. These quality control measures are intended to further ensure high quality monitoring data and to prevent unnecessary data loss. Once a week, a one-point quality control check (precision audit) is done along with the daily zero and span check. The zero, span and precision one-point quality control check are scheduled by the OAQ/AMS/LEADS

Administrator and are set to run at midnight. The span concentration is 70-90% of the full range of the analyzer and the precision level check is .090 ppm for O_3, SO_2, NO_2 and 9 ppm for CO. For data validation, the span must be ≤ ±7% for ozone and ≤ ±10% for SO2, CO, and $NO/NO_2/NO_x$. The One-Point Quality Control Check must be ≤ ±7% for ozone, ≤ ±10% for SO_2 and CO, and ≤ ±15% for $NO/NO_2/NO_x$. The results from the zero and span check should also be used as follows: (1) when the cumulative zero or span drift exceeds the zero or span drift limits for calibration, a calibration should be performed immediately and (2) to make a determination if the frequency of zero/span checks should be increased (e.g., change the schedule of zero/span checks from every two weeks to weekly).

On-site manual span/precision audits may be conducted by IDEM quality assurance staff on an as needed basis such as:

- LEADS communication malfunction

- Unstable or failing remote audit results.

<u>(Span Drift and Zero Drift) Control Chart</u>

A control chart should be maintained for span and zero checks. This chart will serve to identify drift patterns and preliminarily determine the need for a calibration. The USEPA Quality Assurance Handbook for Air Pollution Measurement Systems Volume II, Section 10 provides information on quality control and useful tips on what can be performed. Control limits should be equal or more stringent than the limits shown in Table 2.

Control limits based on the operator's actual zero and span drift results may be calculated by the procedure described in the USEPA Quality Assurance Handbook for Air Pollution Measurement Systems Volume I:

A. Using existing zero and span drift data from similar analyzers in the network; or

B. Using the calibration control limits of Table 2 until data from at least twenty (20) zero and span checks have been accumulated.

In order to establish these control limits in a timely manner, zero and span checks should be performed daily. Statistically, three standard deviations for control limits are recommended as an indicator for a calibration. These limits correspond to the 99.7% probability interval.

Frequent review and interpretation of the control chart is important. Various criteria are used to determine if an "out-of-control" condition exists for an analyzer. These criteria are described in the USEPA Quality Assurance Handbook for Air Pollution Measurement Systems Volume II.

Table 2
Audit Matrix

Analyzer	Zero/Span/ One-Point Quality Control Check frequency	PPM precision check Concentration	Span data validation check	Multi-point accuracy frequency (All Annually)	PPM multi-point accuracy concentration	Limits
SO_2 Fluorescence Coulometric UV Photometry	Biweekly (LEADS sites daily for zero/span and weekly for One-Point Quality Control)	.01-0.1	70-90% full scale response	A minimum of 25% of the total number of analyzers each quarter	.0500-.0999 .1500-.2599 .2600-.7999	For audit levels 3-10: If the obs. conc. is > 7.5% of the std. Conc.: recal. If > 15%, invalidate and recal. For audit levels 1-2, use +/-1.5 ppb or 15% for data validity
CO Infrared	Same as above	1-10	Same as above	Same as above	3.000-7.999 16.000-30.999 40.000-50.000	Same as above except for audit levels 1-2, use +/-0.03 ppm or 15% for data validity
O_3 UV Photometry Chemilum-inescence	Same as above	.01-0.1	Same as above	Same as above	.070-.089 .140-.169 .190-.259	Same as SO2 above
NO-NO_x-NO_2 Chemilum-inescence	Same as above	.01-0.1 NO_2 with .08-.12 remaining NO	Same as above	Same as above	.0500-.0999 .1000-.2999 .3000-.4999 with .08-.12 remaining NO	Same as SO2 above

For reporting of Precision and Accuracy checks, see Chapter 13 of the IDEM, OAQ, QA Manual.

All calibrators or audit equipment must meet the certification requirements of Chapter 6 of the IDEM, OAQ, QA Manual.

3.4 Continuous Sampler Checks

All continuous data is audited to assure correctness and completeness. Specific procedures and requirements are covered in Chapter 12 of the IDEM, OAQ, QA Manual. Table 3 lists requirements for continuous checks.

Table 3
Continuous Analyzer Checks

Type	Frequency	Limits	Action
One-Point Quality Control	Once per two weeks (LEADS sites once a week)	<u><</u>±7% of standard for O3; <u><</u>±10% of standard for SO2 and CO <u><</u>±15% for NO2/NOx/NO	Research possible cause; if needed, invalidate data, perform maintenance, then recalibrate
Validation (Span) point	Once per two weeks (LEADS sites daily)	<u><</u>±7% of standard for O3; <u><</u>±10% of standard for SO2, CO, and NO2/NOx/NO	Research possible cause; if needed, invalidate data, perform maintenance, then recalibrate
Daily Span Drift	Once per two weeks (LEADS sites daily)	Span drift $\leq$±7% for O_3; Span Drift $\leq$±10% for CO, $NO_2/NO_x/NO$; and SO_2	Research with One-Point Quality Control check; if needed, invalidate data, perform maintenance, then recalibrate
Daily Zero Drift	Once per two weeks (LEADS sites daily)	Zero drift $\leq$±3.0 ppb (24 hr) and $\leq$±5.0 ppb (>24hr-14 days) for O3, $NO_2/NO_x/NO$, and SO_2; Zero drift $\leq$±0.4 ppm (24 hr) and $\leq$±0.6 ppm (>24hr-14 days) for CO	Research with Span and One-Point Quality Control check; if needed, invalidate data, perform maintenance, then recalibrate
Each site Each parameter SO_2, O_3, CO, NO, NO_x, NO_2	See Chapter 12	See Chapter 12	See Chapter 12

3.5 Intermittent Sampler Calibration Requirements

Additional information for any of the following requirements may be found in Chapter 7 of this Manual.

3.5.1 Pb, TSP, PM_{10}

Intermittent Pb, TSP, or PM_{10} samplers should be recalibrated when:

A. The sampler’s flow is greater than ±5.0% from the auditor’s flow.

B. A motor is replaced.

C. Any repairs to a flow control device are performed.

D. The difference between initial and final flows is greater than ±10%.

E. Any other indication of inaccurate flow is found.

F. A period of three months has elapsed since the last calibration.

3.5.2 TEOM, BAM, SHARP, and $PM_{2.5}$

Continuous monitors (*TEOM (*PM_{10} *only), BAM, and SHARP*) and intermittent $PM_{2.5}$ samplers are to be recalibrated when:

A. The sampler's flow is greater than ±4% ($PM_{2.5}$ and BAM), ±5% (SHARP), ±10% (TEOM) from the auditor's flow and ±5% ($PM_{2.5}$ and BAM) from the design flow rate.

B. A pump is replaced.

C. Any repairs to a flow control device are performed.

D. Any other indication of inaccurate flow is found.

E. A period of one year has elapsed since the last calibration.

F. New software is loaded.

3.6 Intermittent Sampler Audit Requirements

The intermittent sampler audit requirements listed in Table 1 above are the minimum requirements, and these are based on what is required in Volume II of the Quality Assurance Handbook for Air Pollution Measurement Systems. The IDEM, OAQ, Air Monitoring Branch, Ambient Monitoring Sections perform monthly verifications on all TSP, Pb, PM_{10} and $PM_{2.5}$ samplers while the Quality Assurance Section performs an accuracy audit on each of these samplers every quarter. Results of all this work is used to determine data validation.

3.7 Intermittent Sampler Checks

The data check process, for intermittent sampling analyzers, requires certain "audits" to be performed on the sampling portion (filter and data card) and the analytical portion (filter weighing and calculation). Table 4 summarizes and references these requirements.

Table 4
Intermittent, BAM, SHARP, and TEOM Data Checks

Parameter	Requirement	Corrective Action
Sample Filters	1. Elapsed time 1440 min. must be within ±60 min. 2. All data card information must be complete. 3. No bleed off. 4. No missing filter pieces. 5. No contamination. 6. Initial and final standard flows of TSP & Pb must be within 1.1 to 1.7 m^3/min. 7. Initial and final actual flows of PM_{10} (High Vol) must be within 1.02 to 1.24 m^3/min on sample day. 8. $PM_{2.5}$ and continuous flows 16.67 lpm actual flow ±10% on sample day. 9. Initial and final flows must agree with ±10%. 10. Orifice and other flow devices must be calibrated/verified annually.	See Chapters 7 and 11 See Chapter 6
Filter Conditioning: PM_{10}, Pb $PM_{2.5}$	 1. Temp. 15 to 30 °C (±3 °C SD) over 24-hour average 2. R.H. 20-45% (±5% SD) over 24-hour average 1. Temp. 20 to 23 °C (±2°C) over 24-hour average 2. R.H. 30% - 40% (±5% SD) over 24-hour average	 See Chapter 7 See Chapter 7
Filter Analysis for Hi-vol method: PM_{10}	1. 7% with a minimum of 3 exposed filters re-weighed agree within ±5.0 mg. 2. 7% with a minimum of 3 unexposed filters re-weighed must agree within ±2.8 mg. 3. 7% of calculations are recalculated and agree within ±3%.	See Chapter 7
Filter Analysis: $PM_{2.5}$	1. Neutralize electrostatic charge. 2. Stabilize balance to within ±2 μg. Drifts < 3 μg in 5-10 sec's. 3. Working Std. must agree within ±3 μg of certified values. 4. The lab blank filter must agree within 15 μg. 5. The field blank filter measurements must agree to within 30 μg. 6. For a group up to 50, 4 filters must be re-weighed and agree within 30 μg. 7. For a group greater than 50, 7 filters must be re-weighed and agree within 30 μg.	See Chapter 7
Filter Analysis: PM_{10}	1. Neutralize electrostatic charge. 2. Stabilize balance to within ±4 μg of true zero. 3. Working Std. must agree within ±3 μg of certified values. 4. The lab blank filter must agree within ±15 μg. 5. The field blank filter measurements must agree to within ±30 μg. 6. Per weighing session, 1 filter (or 10% per weighing session) must be re-weighed and agree within 15 μg.	See Chapter 7

4.0 Network Design and Probe Siting Criteria

4.1 Introduction - Objectives and Spatial Scale

Monitoring networks must be designed in such a way that the data obtained is representative of the appropriate area to meet monitoring objectives. This section discusses the relationship between spatial scale and the purposes for which the data should be used. USEPA has additional details for other parameters, which are contained in 40 CFR Part 58, Appendix D and E.

4.1.1 Matching Monitoring Objectives and Spatial Scales

When designing a monitoring program for SLAMS/NAMS networks, one of the following six (6) objectives should be considered:

A. Determine the highest concentrations expected to occur in the area covered by the network.

B. Determine representative concentrations in areas of high population density.

C. Determine the impact of specific sources on ambient pollutant concentrations.

D. Determine general background concentration levels.

E. Determine the extent of regional transport among populated areas, and in support of secondary standards.

F. Determined welfare-related impacts in the more rural and remote areas.

For each of these objectives, there are appropriate spatial scales for providing a representation of the concentrations. This manual defines the various scales as follows (unless otherwise specified):

Micro Scale - Concentrations representative of the air in an area with dimensions ranging from several meters up to 100 meters.

Middle Scale - Concentrations representative of the air in an area with dimensions ranging from 100 to 500 meters.

Neighborhood Scale - Concentrations representative of the air in an area with dimensions ranging from 0.5 to 4.0 kilometers.

Urban Scale - Concentrations representative of the air in an area with dimensions ranging from 4.0 to 50.0 kilometers.

Regional Scale - Concentrations representative of the air in a large, usually rural area of homogeneous geography extending from tens to hundreds of kilometers.

National and Global Scales - These scales represent concentrations characterizing the nation or the globe as a whole.

Table 5 shows the relationship between monitoring objective and spatial scale. These are generally the only scales that should be used.

Table 5
Objectives and Monitoring Scale

Monitoring Objective	**Appropriate Siting Scales**
Highest Concentration	Micro, Middle, Neighborhood (sometimes Urban/Regional for secondarily formed))
Population Exposure	Neighborhood, Urban
Source Impact	Micro, Middle, Neighborhood
General/Background & Regional Transport	Urban/Regional
Welfare – Related	Urban/Regional

4.1.2 Specific Pollutant Scales

The appropriate scale of representativeness varies based on the pollutant and the monitoring objective. This is because pollutants behave differently from each other in the atmosphere and because the sources of pollutants vary greatly. Table 6 gives the appropriate scales for each pollutant.

Table 6
Summary of Spatial Scales SLAMS, NCORE, PAMS, and Open Path (OP) Sites

Spatial Scale	Scale Applicable for SLAMS							$PM_{10-2.5}$	NCORE	CSN	NATTS	PAMS	OP
	SO_2	CO	O_3	NO_2	Pb	PM_{10}	$PM_{2.5}$						
Micro	*	*		*	*	*	*	*					
Middle	*	*		*	*	*	*	*					*
Neighborhood	*	*	*	*	*	*	*	*	*	*	*	*	*
Urban	*		*	*			*		*	*	*	*	*
Regional			*				*		*		*		*

Taking into consideration monitoring objectives and the appropriate siting scales for each pollutant, it is possible to design a network that will yield high quality data. The following sections of this manual give specific siting information for each major pollutant.

4.2 Sampling Probes and Manifolds

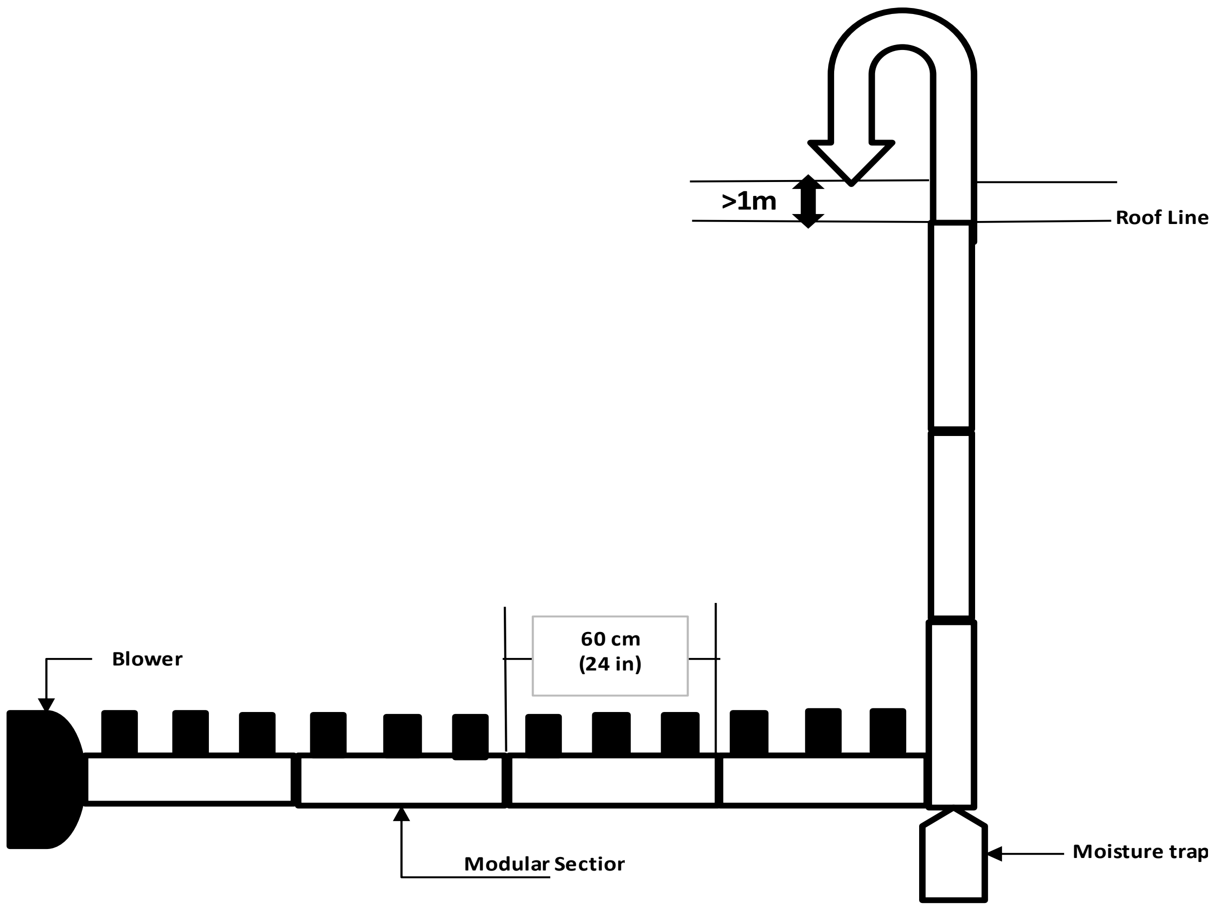
4.2.1 Design of Probes and Manifolds for Automated Methods

Some important variables affecting the sampling manifold design are the diameter, length, flow rate, pressure drop, and construction materials. Considerations for these parameters are discussed below for the *conventional manifold* design. In some instances individual Teflon sampling lines are used, which may access the ambient air through one port (with a number of individual lines) but each line would run directly to an analyzer.

4.2.1.1 Conventional Manifold Design

A conventional horizontal manifold system should be constructed of inert materials such as Pyrex glass and/or Teflon, and modular sections to enable frequent cleaning. The system (Figure 1) consists of a vertical "candy cane" protruding through the roof of the shelter with the horizontal sampling manifold connected by a tee to the vertical section. Connected to the other vertical outlet of the tee is a bottle for collecting heavy particles and moisture before they enter the horizontal section. A small blower, 1700 lpm at 0 cm of water static pressure, is at the exhaust end of the system to provide a flow through the system of approximately 3 to 5 times the total sampling requirements or at a rate equal to the total sampling requirement plus140 lpm.

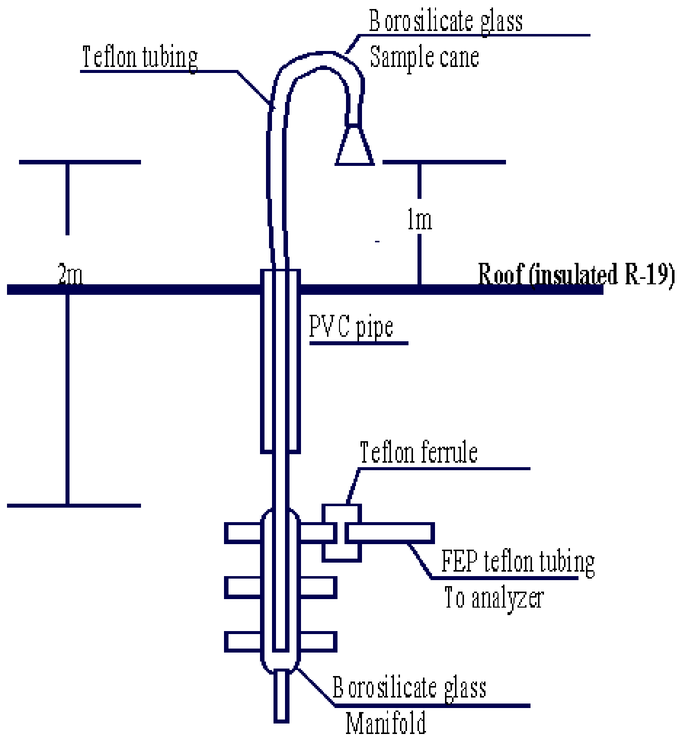
Figure 1
Conventional Manifold System



4.2.1.2 Alternate Manifold Design

This type of manifold system is known as the California Air Resources Board (CARB) or "Octopus" and is illustrated in Figure 2. The "CARB" has a reduced profile, i.e., there is less volume in the cane and manifold; therefore, there is less of a need for bypass flow. These manifolds allow more options than the other conventional manifolds. If the combined flow rates are high enough with the instruments at the monitoring location, bypass flow devices are not required.

Figure 2
Alternate Manifold Design



This section will supply detailed siting information for each monitoring parameter. Representative scales will be discussed, and then probe-siting criteria will be listed. Further information can be found in 40 CFR Part 58 Appendices D and E.

4.2.1.3 Residence Time Determination

The residence time of pollutants in the manifold is critical. Residence time is defined as the amount of time that it takes for a sample of air to travel from the opening of the cane inlet to the instrument and is required to be less than 20 seconds for reactive gas monitors. It is recommended that the residence time within the manifold and sample lines to the instrument be less than 10 seconds. If the volume of the manifold *does not allow this to occur*, then a blower or vacuum pump can be used to decrease the residence time. The residence time for a manifold is determined in the following way. First the volume of the cane, manifold, and sample lines must be determined using the following equation:

$$\text{Total Volume} = C_v + M_v + L_v$$

Where:

C_v	=	Volume of sample cane and extensions
M_v	=	Volume of sample manifold and trap
L_v	=	Volume of instrument lines

Each of the components of the sampling system must be measured individually. To measure the volume of the components, use the following equation:

$$V = \pi * (d / 2)^2 * L$$

Where:

V = Volume of the component
π = 3.14159
L = Length of the component
d = inside diameter
* = multiply, / = divide

Once the total volume is determined, divide the volume by the flow rate of all instruments. This will give the residence time. If the residence time is greater than 10 seconds, attach a blower or vacuum pump to increase the flow rate and decrease the residence time. Residence time should be determined when the site is first installed and then when sample lines are changed out, the instrument is changed out, and during routine site evaluations. This will be documented on the site's log as well as any site evaluation sheets.

Generally, it has been determined that there are no significant losses of reactive gas (O_3) concentrations in conventional 13 mm inside diameter sampling lines of glass or Teflon if the sample residence time is 10 seconds or less. This holds for sample lines up to 38 meters (125 ft) in length, which collect substantial amounts of visible contamination due to ambient aerosols. However, when the sample residence time exceeds 20 seconds, a loss is detectable and at 60 seconds the loss is nearly complete. Care must also be taken to ensure that a pressure drop on the manifold does not exceed 0.25 inches. A large drop may result in a leak. A certified manometer can be used to measure the pressure drop. This measurement is recommended annually.

4.2.2 Ozone (O_3)

4.2.2.1 Representative Scales

A. Neighborhood Scale stations represent conditions of peak concentration in areas with similar factors influencing the concentration. A station downward (predominate summer/fall wind direction) of the central business district on the fringes of town might be classified neighborhood.

B. Urban Scale stations give data on generalized concentrations over a large urban area. These stations are useful in designing area wide control strategies. Urban scale stations can also be used to measure high concentrations in an area downwind from high precursor emissions.

C. Regional Scale stations (SLAMS only) are useful for determining the ozone that is transported into an area.

4.2.2.2 Probe Siting Criteria

4.2.2.2.1 Horizontal and Vertical Probe Placement

See Chapter 2, Section 2.1

4.2.2.2.2 Spacing from Obstructions

See Chapter 2, Section 2.2

4.2.2.2.3 Spacing from Roads
See Chapter 2, Section 2.3

4.2.2.2.4 Spacing from Trees
See Chapter 2, Section 2.4

4.2.3 Sulfur Dioxide (SO_2)

4.2.3.1 Representative Scales

A. Micro Scale

B. Middle Scale stations are most representative of concentrations in urban areas and are useful for assessing the effectiveness of control strategies as well as for monitoring episodes.

C. Neighborhood Scale stations are representative of suburban or less densely populated areas. These stations are useful for predicting concentrations in growth areas.

D. Urban Scale stations are representative of concentrations in an entire urban area.

4.2.3.2 Probe Siting Criteria

4.2.3.2.1 Horizontal and Vertical Probe Placement
See Chapter 3, Section 2.1

4.2.3.2.2 Spacing from Obstructions
See Chapter 3, Section 2.2

4.2.3.2.3 Spacing from Trees
See Chapter 3, Section 2.3

4.2.4 Carbon Monoxide (CO)

4.2.4.1 Representative Scales

A. Micro Scale stations represent concentrations in street canyons or near major roadways. These sites reflect peak concentrations and must be representative of concentrations in several areas of a city.

B. Middle Scale stations (SLAMS only) are representative of long stretches of urban streets, such as strip development and freeway corridors. Middle scale would also include indirect sources, such as shopping centers and office building parking lots.

C. Neighborhood Scale stations are representative of concentrations in areas of high population density and high traffic density. These stations need to be representative of urban regions with dimensions of a few kilometers and should be representative of similar areas in other parts of town.

4.2.4.2 Probe Siting Criteria

4.2.4.2.1 Horizontal and Vertical Probe Placement
See Chapter 4, Section 2.1

4.2.4.2.2 Spacing from Obstructions
See Chapter 4, Section 2.2

4.2.4.2.3 Spacing from Roads
See Chapter 4, Section 2.3

4.2.4.2.4 Spacing from Trees
See Chapter 4, Section 2.4

4.2.5 Oxides of Nitrogen (NO, NO_2, NO_x) and Total Reactive Oxides of Nitrogen (NO_y)

4.2.5.1 Representative Scales

A. Micro Scale

B. Middle Scale (SLAMS only) stations represent public exposure to NO_2 in populated areas. Stations closer to roadways than allowed in Table 9 must be classified as middle scale.

C. Neighborhood Scale stations are placed in the location with the highest density of NO_x emissions such as the fringe of an urban business district. These stations measure the photochemical production of NO_2.

D. Urban Scale stations must be located downwind from areas of high emissions and are used to measure the NO_2 produced from the reaction of NO and O_3. These stations are normally located downwind in the predominant winter wind direction or in areas where there are high O_3 concentrations and high NO_2 emissions.

4.2.5.2 Probe Siting Criteria

4.2.5.2.1 Horizontal and Vertical Probe Placement
See Chapter 5, Section 2.1

4.2.5.2.2 Spacing from Obstructions
See Chapter 5, Section 2.2

4.2.5.2.3 Spacing from Roads
See Chapter 5, Section 2.3

4.2.5.2.4 Spacing from Trees

See Chapter 5, Section 2.4

4.2.6 Total Suspended Particulate (TSP), $PM_{2.5}$ and PM_{10}

4.2.6.1 Representative Scales

A. Micro Scale stations are used to determine the maximum impact on the public in street canyon type situations.

B. Middle Scale stations should be used to assess short term public exposure and the contribution of indirect sources.

C. Neighborhood Scale stations should be used to determine trends and compliance with standards. These stations often give an indication of concentrations in similar neighborhoods. This definition also includes industrial and commercial neighborhoods.

B. Urban Scale stations are useful for tracking citywide trends.

C. Regional Scale stations supply information about sparsely populated areas or about pollutant transport.

4.2.6.2 Probe Siting Criteria

A. Two (2) to fifteen (15) meters high (see Figure 3) for TSP, $PM_{2.5}$, and $PM_{10.}$ The exception to this rule is PM_{10} micro scale.

B. Two (2) to seven (7) meters high for PM_{10} micro scale (see Figure 3).

C. Two (2) meter separation from walls, parapets, etc.

D. Twenty (20) meters from the drip line of trees.

E. The probe must be two times (2 X) as far away from an obstruction as that obstruction extends above the sample inlet (2 X rule).

F. At least 270^o around the sample inlet must be unrestricted and the 270^o arc must include the prevailing wind direction for the season of expected highest concentration (270^o rule).

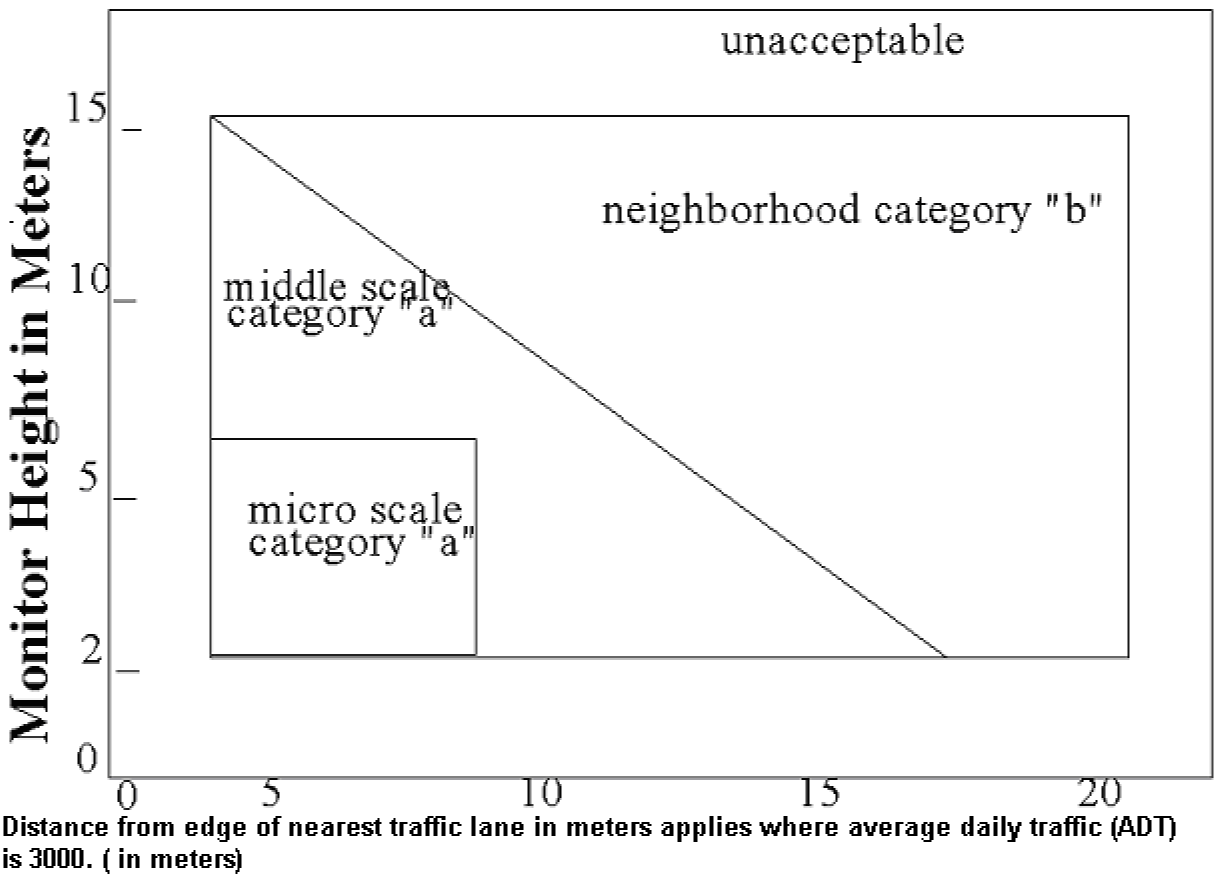
G. See Figures 3 and 4 for spacing from roads.

H. Must be in a paved area or an area with vegetative ground cover.

I. Collocated samplers two (2) to four (4) meters apart and within one (1) meter vertically.

J. Collocated $PM_{2.5}$ samplers one (1) to four (4) meters apart and within one (1) meter vertically.

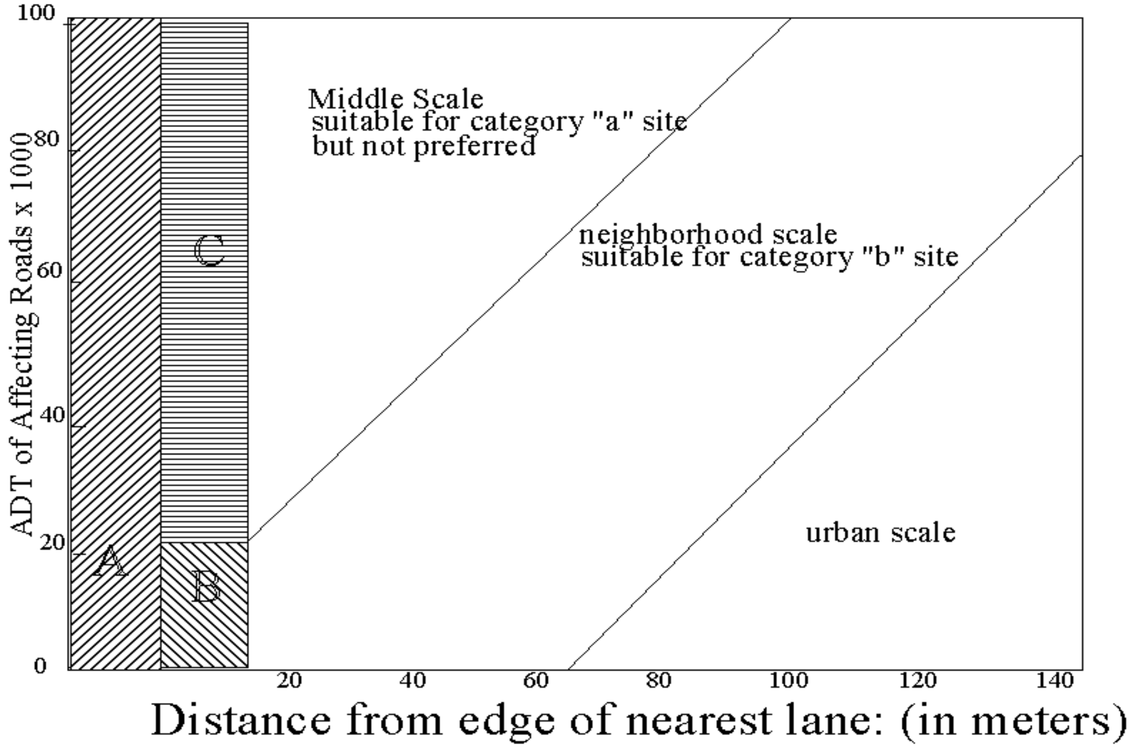
Figure 3
Acceptable Areas for TSP, $PM_{2.5}$ and PM_{10}
Micro, Middle, and Neighborhood Scale Samplers



Category A: Community oriented site in area of maximum concentration.

Category B: Area of poor air quality with high population density or representative of maximum population impact.

Figure 4
Acceptable areas for $PM_{2.5}$ and PM_{10}
Micro, Middle, Neighborhood, and Urban Samplers



A. Unacceptable at any traffic volume
B. Unacceptable as category (a) site
C. Preferred area for category (a) site. Use micro scale if monitor is two to seven meters high, middle scale otherwise

4.2.7 Lead (Pb)

4.2.7.1 Representative Scales

A. Micro Scale - This scale is the preferred scale for Pb monitoring. This category (a) monitor should be located adjacent to the roadway with the largest traffic volume. If a micro scale station cannot be found, a middle scale station is acceptable as category (a). A micro scale station would be located in areas such as street canyons and traffic corridors. Point sources, such as, lead smelting, battery recycling, and primary copper smelting facilities are sites that should be monitored. For non-roadway sites (e.g., near point sources), micro scale may extend up to 100 meters.

B. Middle Scale - For roadway sites, middle scale extends 50-150 meters. For other types of sites, middle scale could extend 100-500 meters. Middle scale is useful for sites such as schools near major highways.
C. Neighborhood Scale - This type of station should represent conditions where children live and play, as they are more susceptible to the effects of lead.

4.2.7.2 Probe Siting Criteria

4.2.7.2.1 Vertical Probe Placement:

Micro scale lead sites are required to have sampler inlets between 2 and 7 meters above ground level.

4.2.7.2.2 Spacing from Obstructions

See Chapter 7, Part 2, Section 4.1

4.2.7.2.3 Spacing from Roads: (Micro and Middle Scale)

A. For micro scale traffic corridor sites, the location must be between 5 and 15 meters from the major roadway.

B. For micro scale street canyon sites the location must be between 2 and 10 meters from the roadway.

C. For middle scale sites, a range of acceptable distances from the roadway can be found in 40 CFR Part 50, Appendix L.

4.2.7.2.4 Spacing from Trees: (Micro, Middle (A), and Neighborhood (B))

See Chapter 7, Part 2, Section 4.1

4.2.8 Air Toxics (VOC’s, NMOC’s, TO-15's, PAMHC’s, Carbonyl’s, Lead)

4.2.8.1 General Project Description

See Chapter 8, Section 1.0

4.2.8.2 Quality Assurance Objectives

See Chapter 8, Section 1.6

4.2.8.3 Sampling Procedures

See Chapter 8, Sections 3.2, 4.2, 5.2, 6.0

4.2.8.4 Chain-of-Custody

See Chapter 8, Sections 3.3, 4.3, 5.3

4.2.8.5 Calibration Procedures and Frequency

See Chapter 8, Sections 3.5, 4.5.

4.2.8.6 Analytical Equipment

See Chapter 8, Sections 3.4, 4.4, 5.4

4.2.8.7 Quality Control and Quality Assurance

See Chapter 8, Sections 3.8, 4.8, 5.6, 5.7, 6.1

4.2.8.8 Systems Audits

See Chapter 8, Sections 3.10, 4.10, 6.1

5.0 Air Monitoring Resource Criteria

5.1 Staffing Criteria

A. Staff size, organization, qualifications, and utilization must be adequate to achieve the results in the program plan commitments. These should include at least one person designated as quality control officer.

B. A formal staff training format should be developed to train new employees and periodically update employees' skills and program operations. Formal staff training should be coordinated with the Quality Assurance Section of the Office of Air Quality on a semi-annual basis for those person(s) engaged in operating and calibrating continuous analyzers. Standard literature references should be readily available to all staff members including the Federal Register, manufacturer's instrument manuals, and quality assurance guideline documents related to the program objectives.

Table 7
Performance Specifications for Automated Methods

Performance Parameter	Units	Sulfur Dioxide (SO2)		Photochemical Oxidants (O_3)	Carbon Monoxide (CO)		Nitrogen Dioxide (NO_2)
		Std. range	Lower range		Std. range	Lower range	
Range	PPM	0-0.5	<0.5	0-0.5	0-50	<50	0-0.5
Noise	PPM	.001	0.0005	.005	0.2	0.1	.005
Lower Detectable Limit	PPM	.002	0.001	.010	0.4	0.2	.010
Each Interferant	PPM	±.005	±.005	±.02	±1.0	±0.5	±.02
Total Interferant	PPM	---	---	.06	---	---	.04
Zero Drift, 12 and 24 hour	12 + 24 hr. ppm	±.004	±.002	±.02	±0.5	±.03	±.02
Span Drift, 24 hour							
20% of Upper range limit	Percent	---	---	±20.0	---	---	±20.0
80% of Upper Range Limit	Percent	±3.0	±3.0	±5.0	±2.0	±2.0	±5.0
Lag time	Minutes	2	2	20	2.0	2.0	20
Rise time	Minutes	2	2	15	2.0	2.0	15
Fall time	Minutes	2	2	15	2.0	2.0	15
Precision							
20% of Upper Range Limit	PPM Percent	--- 2	--- 2	.010 ---	--- 1.0	--- 1.0	.020
80% of Upper Range Limit	PPM Percent	--- 2	--- 2	.010 ---	--- 1.0	--- 1.0	.030

Note: Analyzers for SO_2, O_3, and NO-NO_x that have a range greater than that listed in this table must meet the requirements of 40 CFR Part 53 and/or contained in USEPA listing of designated reference or equivalent analyzers. NCORE performance specifications can be found in the chapters covering each of the specific parameters.

5.2 Ozone (O_3)

The agency must have the necessary hand tools, electrical testing, and calibration equipment available to calibrate, operate, maintain, and assure the data quality in the monitoring program. The following equipment is required:

A. Ozone Analyzer – which meets the requirements of the Federal Reference or equivalent method or grandfather clause in accordance with 40 CFR Part 53 and Table 7.

B. Calibration System to include:

1. Air flow controller
2. Ozone generator
3. Dilution system

C. 40 CFR Part 50, Appendix D specifies the calibration procedures for ambient ozone monitors will be based on ultraviolet photometry or on alternative transfer standards that are traceable to UV Photometry. Chapter 2, of this manual, lists the specific requirements for all of the above.

D. Flow Meters - capable of measuring the flow rates over the operation and calibration range of the instrument with an accuracy of ±2%.

E. Data Recording Device - for data collection, such as a strip chart recorder or a computer.

The above requirements are listed in Table 8.

Table 8
Ozone Equipment Procurement Matrix

Equipment	**Acceptance**	**Frequency and Method of Measurement**	**Action if Requirement not Met**
Ozone Analyzer	EPA designated method equipment	Mfg. should provide a strip chart recording of the performance	Return to Mfg.
Recorder	Compatible with Analyzer output	Check upon receipt. Calibrate speed & output once per year.	Return to supplier
Sample lines	Teflon	Check upon receipt	Return to supplier
Calibration equipment	Chapter 2 of the QA manual	See same	Return to supplier
Flow meter	All data points within ±2% of the best-fit curve	Check upon receipt	Return to supplier
Ethylene	Pre-purified C.P. grade minimum	Mfg. should supply	Return to supplier

Additional equipment, that may be required for a particular agency's calibration use, is included in Table 12.

5.3 Total Suspended Particulate, $PM_{2.5}$ and PM_{10}

5.3.1 TSP

The agency must have the necessary hand tools, electrical testing, and calibration equipment available to maintain, operate, calibrate, and assure the data quality in the monitoring program. The following equipment is required:

5.3.1.1 TSP Sampler Specifications

A. High Volume Samplers must meet the requirements of 40 CFR Part 50, Appendix B. In general, samplers must be capable of passing ambient air through a 406.5 cm portion of a 20.3 by 25.4 cm glass fiber filter at a rate of at least 1.7 m^3/min for 24 hours with the voltage ranging from 110 to 120 with third wire safety grid. The shelter should be made of heavy gauge aluminum or painted exterior plywood, such that the filter is protected from precipitation and debris by a gable roof, and be rectangular in shape.

B. A flow rate measuring device meeting the specifications of 40 CFR Part 50, Appendix B 7.4 (Marked in arbitrary units from 0-50/70 and capable of being calibrated).

C. An orifice calibration unit with electronic manometer meeting the specifications of the Federal reference or equivalent 40 CFR Part 50 Appendix B 7.8, or Chapter 7 of IDEM QA manual. An orifice calibration unit consists of a metal tube 7.6 cm (inside diameter), 15.9 cm in length with a static pressure tap 5.1 cm from one end. The tube nearest the pressure tap is flanged to about 10.8 cm (outside diameter) with a male thread of the same size as the inlet end of the high volume air sampler. A single metal plate 9.2 cm (diameter) X .24 (thick) and a central orifice 2.9 cm in diameter is held in place at the air inlet with a female threaded end. Resistance plates with 5, 7, 10, 13, and 18 uniform diameter holes are used to simulate the resistance of filters as they load with particulate matter. A three (3) hole plate may be used in lieu of a five (5) hole plate. For a variable orifice uses a filter instead of plates.

D. A positive displacement meter system meeting the requirements of 40 CFR Part 50, Appendix B 9.2.1 is used as a primary standard.

E. Differential manometer meeting capable of measuring at least 40 cm (15.7 inches) of H_2O.

F. Timers meeting ±2 min/24 hr accuracy.

G. A barometer capable of measuring with an accuracy of ±5 mmHg.

H. A temperature device capable of measuring to the nearest degree with an accuracy of ±1 °C.

The above requirements are listed in Table 9.

Table 9
PM_{10}/TSP Equipment Procurement
Field Sampling Equipment

Equipment	Acceptable Limits	Frequency and Method of Measurement	Action if requirement not met
Sampler	Sampler complete, see above	Visual observation	Reject or repair
Orifice calibration unit	Flow rate from Mfg. Equal actual ±4%	On receipt, check against primary standard (annually).	1) Adopt new calibration curve 2) Reject if evidence of damage
Elapsed time meter	24 hrs. ±2 min.	On receipt, check against primary standard (annually).	Reject or adjust
Positive displacement meter	Primary standard	Verify from supplier.	As above
Barometer	Accuracy to ±0.2%	Certify prior to use and annually.	Calibrate or replace
Temperature device	Accuracy ±1 °C	Certify prior to use and annually.	Replace

Table 10
PM_{10}/TSP Equipment Procurement
Laboratory Analysis Equipment

Equipment	Acceptable Limits	Frequency and Method of Measurement	Action if requirement not met
Analytical balance	See Chapter 7.	Gravimetric test weighing at purchase and during periodic calibration checks (See Chapter 7)	Have balance maintained and calibrated by manufacturer (See Chapter 7)
Thermometer	Accuracy ±1 °C	Certify prior to use and annually (liquid, electronic, or mechanical).	Replace
Relative humidity Indicator	Indicator must equal psychrometer reading ±6% RH	Certify prior to use and annual.	Calibrate or replace
Numbering device	Indelible ink	Upon receipt	Return
Filters	99% collection efficiency for 0.3 µm by DOP	Upon receipt	Return
Light table box	Strong opaque light source	Upon receipt	Return
Desiccator	Must accommodate 8"x 10" unfolded filter, @ 20-45%	Upon receipt	Return

5.3.2 $PM_{2.5}$ and PM_{10}

The agency must have the necessary hand tools, electrical test equipment and calibration equipment available to calibrate, operate, maintain, and assure the data quality in the monitoring program.

The following equipment is required:

A. PM_{10} samplers must collect particles at a constant flow rate under actual conditions of 1.13 m^3/min ±10% of the design flow rate.

B. $PM_{2.5}$ samplers meeting the requirements of 40 CFR Part 50, Appendix L.

C. Flow measurement device accurate to within ±2% as per 40 CFR Part 50, Appendix J 7.1.4.

D. Timing control device capable of starting and stopping the sampler at 24 hr ±1 hr intervals as per 40 CFR Part 50, Appendix J 7.1.5.

E. Elapsed time meter accurate to ±2 minutes/24hr.

F. Quartz fiber filters with a collection efficiency of 99 percent (DOP test - 2986) as per 40 CFR Part 50, Appendix J 7.2.2.

G. Filter conditioning environment where temperature is maintained at 15 to 30 °C ±3 °C and 20-45% R.H. ±5% as per 40 CFR Part 50, Appendix J 7.4.1, 7.4.2, 7.4.3., 7.4.4.

H. Laboratory equipment meeting the requirements of Table 10.

5.3.2.1 Representative Scales

A. Spatial Scale range from 0.1 to 0.5 km^2 for small area and up to 100's of km^2 for large area.

B. Temporal Scale focus is on annual or geometric mean concentration, or 24 hr. average concentration. For more information, refer to 40 CFR Part 50, Appendix L and J and Part 58, Appendix D and E.

5.3.2.2 $PM_{2.5/10}$ Sampler Design Specifications

See 40 CFR Part 50, Appendix L or See Table 6-1 Design/Performance Specifications in "Model Quality Assurance Project Plan for the PM Ambient Air 2.5 Monitoring Program at State and Local Air Monitoring Stations (SLAMS)" http://www.epa.gov/ttnamti1/files/ambient/pm25/qa/totdoc.pdf and Chapter 7 Part 1, Section 1.1

5.3.2.3 $PM_{2.5/10}$ Filter Specifications

See 40 CFR Part 50, Appendix L or See Table 6-1 Design/Performance Specifications in "Model Quality Assurance Project Plan for the PM Ambient Air 2.5 Monitoring Program at State and Local Air Monitoring Stations (SLAMS)" http://www.epa.gov/ttnamti1/files/ambient/pm25/qa/totdoc.pdf

5.3.2.4 $PM_{2.5/10}$ Siting Criteria

See Chapter 7, Part 1, Section 4.1

5.3.2.5 $PM_{2.5/10}$ Installation Procedures

See Chapter 7, Part 1, Section 4.2

5.3.2.6 $PM_{2.5/10}$ Sampling Operations

See Chapter 7, Part 1, Section 4.3

5.3.2.7 $PM_{2.5/10}$ Calibration Procedures

See Chapter 7, Part 1, Section 5.0

5.3.2.8 $PM_{2.5/10}$ Audit Procedures, and Precision and Accuracy assessment
See Chapter 7, Part 1, Sections 6.0 - 7.3

5.3.2.9 $PM_{2.5/10}$ Maintenance
See Chapter 7, Part 1, Section 8.0

Additional equipment that may be required for a particular agency's use is listed in Table 12.

5.4 Carbon Monoxide (CO)

The agency must have the necessary hand tools, electrical testing, and calibration equipment available to calibrate, operate, maintain, and assure the data quality in the monitoring program. The following equipment is required:

A. Carbon Monoxide Analyzer meeting the specific requirements of 40 CFR Part 53, Chapter 4 of the QA Manual, and Table 7.

B. Calibration System capable of calibrating the monitor over its full operating range. The carbon monoxide cylinder gas must give evidence of traceability to NIST. See Chapter 6 of the QA manual for certification requirements.

C. Flow Meter capable of measuring the flow rates over the operation and calibration range of the instrument with an accuracy of ±2% as per 40 CFR Part 50 Appendix C 4.2.1. and 4.2.2.

D. Data Recording Device for data collection, such as a strip chart recorder or a computer.

5.5 Nitrogen Dioxide (NO_2)

The agency must have the necessary hand tools, electrical testing, and calibration equipment available to calibrate, operate, maintain, and assure the data quality in the monitoring program.

A. Oxides of Nitrogen Analyzer meeting the requirements of 40 CFR Part 53, Table 7, and Table 11.

B. Calibration System capable of calibrating the monitor over its full operating range. The nitric oxide cylinder gas must give evidence of traceability to NIST. See Chapter 6 of the QA manual for certification requirements.

C. Flow Control Meter capable of controlling and measuring flow rates over the operating and calibrating range with an accuracy of ±2% as per 40 CFR Part 50 Appendix F 2.2.3.

D. Data Recording Device for data collection, such as a strip chart recorder or a computer.

The above requirements are listed in Table 11.

Table 11
Nitrogen Dioxide Procurement Matrix

Equipment Chemiluminescence	**Acceptance Limits**	**Frequency and Method of Measurement**	**Action if Requirements Not Met**
Analyzer	Performance in accordance with specifications in Table 5	Mfg. should provide a strip chart verifying	Return to supplier
Recorder	Compatible with output	Check upon receipt, calib. speed and output annually	Return to supplier
Samples, Lines & Manifold	Construction of Teflon or glass	Check upon receipt	Return to supplier
Calibration equipment	40 CFR 50 App. F	Check upon receipt	Return to supplier
Flow meter	±2% from Standard	Verify semi-annually	Return to supplier
Air flow controller	±2% from Standard	Check upon receipt	Return to supplier
Pressure regulator for NO cylinder	Nonreactive diaphragm, internal stable parts	Check upon receipt	Return to supplier
Ozone Generator	Capable of stable levels of Ozone	Check upon receipt	Return to supplier
Fittings & Valves	Teflon connectors	Check upon receipt	Return to supplier
Chambers & Manifolds	Nonreactive glass	Check upon receipt	Return to supplier
Working Standard	Traceable to NIST-SRM	See Chapter 6 of the QA Manual	
NO cylinder gas	Meets limits on traceability.	See Chapter 5 and 6 of the QA Manual	Return to supplier

Table 12 contains additional equipment to assist in the agency's calibrations.

5.6 Sulfur Dioxide (SO_2)

The agency must have the necessary hand tools, electrical testing, and calibration equipment available to maintain, operate, calibrate, and assure the data quality in the monitoring program.

The following equipment is required:

A. Sulfur Dioxide Analyzer meeting 40 CFR Part 53 requirements and Table 7.

B. Calibration System meeting the specifications of 40 CFR Parts 50 and 53, and Chapter 3 of this manual, and capable of operating the equipment over its full calibration range. The SO_2 cylinder gas must give evidence of traceability to NIST. See Chapter 6 of the QA manual for certification requirements.

C. Flow meter capable of measuring the flow rates over the operation and calibration range of the instrument with an accuracy of ±2% as per 40 CFR Part 50 Appendix A 4.1.1 .

D. Data Recording Device for data collection, such as a strip chart recorder or a computer.

Table 12
Matrix for Calibration Equipment

Equipment	Requirement	Frequency & Method of Measurement	Action if Requirements Not Met
Wet test meter	Error not to exceed ±1%	Check upon receipt. Quarterly check with liquid positive displacement technique. See Chapter 6, IDEM/OAQ/QA manual.	Check connections, gravimetrically check volume of standard flask, and repeat calibration. If limits are met, adjust meter as per manufacturer.
Soap bubble meter	Error not to exceed ±1%	Initial calibration upon receipt, Gravimetric displacement method. See Chapter 6, IDEM/OAQ/QA manual.	As per manufacturer's instructions.
Mass flow meter	All data points within ±2% of the best-fit curve	Calibrate vs. bubble or wet test meter quarterly. See Chapter 6, IDEM/OAQ/QA manual.	As per manufacturer's instructions.
Rotameter	As above	Before each field use & after sampling, calibrate vs. wet test meter. See Chapter 6, IDEM/OAQ/QA manual.	As per manufacturer's instructions.
Analytical Balance	See Chapters 7 and 8.	Initially & after moving or rough handling, or when a standard weight cannot be weighed to within tolerances specified.	Repeat check to verify malfunction.
Elapsed time meter	±2 min/24 hrs.	Check every 6 months against an NIST standard for accuracy.	Replace time meter.
ON-OFF timer	±15 min/24 hrs.	Perform quarterly, use calibrated elapsed time meters. See Chapter 6 of IDEM/OAQ/QA manual.	Adjust the tripper switches, replace time meter, & repeat test.
Vacuum gauge	Correct within ±1", 25.4 mmHg	Check quarterly against calibration vacuum gauge or Hg manometer.	

5.7 Facilities

A. Adequate space must be made available to operate, calibrate, and maintain the instruments.

B. The space used for all reference method or equivalent instruments must be maintained at 15 to 33 °C and electrical power should be maintained at any normal line voltage between 105 and 125 V. This does not include the reference method for total suspended particulate or Meteorological parameters.

C. The space used for all Federal reference method or equivalent instruments must prohibit direct sunlight upon the instruments or ancillary equipment. This does not include Federal reference method (High Volume Method) for total suspended particulate or Meteorological parameters.

D. The site used for reference method (High Volume Method) for total suspended particulate must not have a dusty surface.

E. The space used should comply with the Occupational Safety and Health Act and/or the equivalent State safety and health program requirements.

   1. Room space should be adequate to allow free movement for personnel. The floors should be clean, dry, and free from obstacles such as wires, cracks, etc.

   2. An approved fire extinguisher should be immediately accessible around instruments using combustible gases.

   3. Oxidizing and reducing gases should only be used in rooms with good ventilation.

   4. Personnel should be trained in safety and emergency procedures.

F. All facilities and equipment must be maintained with the safety requirements for reference and equivalent method determinations. 40 CFR Part 53.4(b)3; 40 CFR Part 53.9(b).

5.8 Network Design

The air monitoring network must be designed in accordance with State Implementation Plans and subsequent requirements (40 CFR 51). There must be a Monitoring/Quality Assurance Plan describing the network that will prescribe and detail:

A. The basis for the design of the network, selection of instruments, and sampling sites.

B. The locations of the instruments (site locations) by Universal Transverse Mercator (UTM) grid coordinates or the equivalent.

C. The sampling schedules.

D. The methods of sampling and analysis.

E. The method of data handling and analysis procedures.

F. The calibration and quality assurance procedures.

5.9 Network Status Reporting

A. The operator must maintain records identifying the history and status of each air monitoring site. This information must contain at least the following information:

1. AQS Site Identification

2. Photographs or slides of the monitoring site. One photograph or slide toward each of the four compass directions and one close-up photograph of the instrumentation at the site.

3. Date site was started up and date site was shut down, as appropriate.

4. Model, manufacturer, and serial number of instruments at the site and dates each instrument operated.

5. Reasons for periods of missing data.

B. The operator must maintain the correct number and type of instruments as required by the Federal Register and any State of Indiana requirements.

C. The operator must not conduct activities that will reduce the quality and quantity of data that is required to be collected.

D. Manual methods not identified as reference or equivalent methods are obsolete.

5.10 Network Operation and Maintenance

5.10.1 Network Operation

A. Instrument(s) must be operated in strict accordance with the operator's written Standard Operating Procedures. Standard Operating Procedures are derived from the Federal reference or equivalent method(s), the manufacturer's instruction manual and IDEM’s OAQ/QA Manual.

B. A formal written procedure must be adhered to in the operation of the instrument(s).

1. Monitoring schedule
    a. Continuous monitoring
    b. Intermittent monitoring
        i. seasonal
        ii. special study

2. Operational schedule
    a. Calibration
    b. Zero/span checks

C. The operator should maintain an adequate supply of expendable materials necessary to service the instrument.

D. The high volume sample must be picked up and returned for analysis to the laboratory as soon as possible after each sampling period, preferably within 24 hours.

E. Operating schedules (zero checks, span checks, and calibrations) for continuous monitors are determined from well documented past performance data which demonstrates that the instrument is operating within well-defined limits. Examples include:

1. Performance control chart(s)
2. Audit results
3. Collected data
4. Maintenance records

5.10.2 Network Maintenance

A. Maintenance must be performed in strict accordance with the operator's written Standard Operating Procedures.

B. A formal written schedule must be used for performing maintenance on the instruments.

C. This schedule should include the following: preventive, annual, quarterly, monthly, and biweekly maintenance.

D. The operator must have immediate access to an instrument technician. This should be a staff member, but may be the instrument manufacturer's serviceman or equal. Where this capability does not exist within the operating group, a service contract is recommended.